



DECLARATION

I, Miki TAGUCHI of AISIN ENGINEERING CO., LTD. having its place of business at 1-15, Hachiken cho, Kariya city, AICHI, Japan, do solemnly and sincerely declare that I understand the Japanese and English languages and that the attached document is a true and faithful translation made by me of the certified copy of a Japanese Patent Application No.2000-355722.

entitled:

Solid polymer electrolyte fuel cell, electrode, and method for producing electrode thereof

Consisting of a Petition for Patent and the Specification.

Dated this 14th day of May, 2004

Miki TAGUCHI

Japanese Patent Application No. 2000-355722 filed on November 22, 2000

[DOCUMENT NAME]	Petition for patent
[FILE NO.]	AK00-0455
[SUBMITTED TO]	Commissioner for patent
[IPC]	H01M 4/88 H01M 8/10
[INVENTOR]	
[ADDRESS]	1, Asahi-machi, 2-chome, Kariya-shi, Aichi-ken
	c/o Aisin Seiki Kabushiki Kaisha
[NAME]	Hikaru Okamoto

[APPLICANT]	
[ID NO.]	000000011
[NAME]	Aisin Seiki Kabushiki Kaisha
[REPRESENTATIVE]	Kanshiro Toyoda
[INDICATION OF FEE]	
[PAYMENT ACCOUNT NO.]	011176
[FEE AMOUNT]	21,000 yen
[LIST OF APPENDIX]	
[NAME]	Specification 1 set
[NAME]	Drawing 1 set
[NAME]	Abstract 1 set
[PROOF NECESSARY]	Necessary

[Document]

Specification

[Title of the invention]

- 5 Solid polymer electrolyte fuel cell, electrode, and method for producing electrode thereof

[Scope of the claims]

- 10 **[Claim1]** A solid polymer electrolyte fuel cell comprising a solid polymer electrolyte membrane having ion exchange properties, an anode disposed on one surface of the polymer electrolyte membrane, and a cathode disposed on the other surface of the polymer electrolyte membrane characterized in that the cathode comprises a joined diffusion layer by joining at least two gas diffusion layers of a first gas diffusion layer and a second gas diffusion layer having different characteristics from each other in a thickness direction of the cathode.

[Claim2] The solid polymer electrolyte fuel cell and electrode according to claim 1, wherein the cathode further comprises a hydrophilic water storing intermediate layer disposed between the first gas diffusion layer and the second gas diffusion layer of the cathode.

- 20 **[Claim3]** The solid polymer electrolyte fuel cell and electrode according to claim 1, wherein the first gas diffusion layer and the second gas diffusion layer of the cathode differ from each other in at least one of gas permeability in the thickness direction of the cathode, electric resistance and hydrophobicity.

- 25 **[Claim4]** The solid polymer electrolyte fuel cell and electrode according to claim 1, wherein the first gas diffusion layer disposed at a catalytic layer side of the cathode has a small gas permeability and the second gas diffusion layer disposed at a separator side of the cathode has a larger gas permeability than that of the first gas diffusion layer.

[Claim5] A method for producing an electrode of a solid polymer electrolyte fuel cell comprising the steps of:

- 30 forming the second gas diffusion layer;
forming the first diffusion layer by pressing the second gas diffusion layer in a thickness direction so that a density becomes larger than the second gas diffusion layer; and
thermally pressing to join the first diffusion layer and the second diffusion layer.

[Detailed description of the invention]

- 35 **[0001]**

[Technical field of the invention]

The present invention relates to a solid polymer electrolyte fuel cell, electrode, and a method for producing the electrode thereof.

[0002]

[Prior art]

- 5 Conventionally, solid polymer electrolyte fuel cells include a proton-conductive solid polymer electrolyte membrane as a component. The solid polymer electrolyte fuel cell is a device that generates electromotive force by electrochemical reactions between fuel gas such as hydrogen gas and oxidizer gas.

[0003]

- 10 The electrode reaction produced between the hydrogen gas as the fuel gas and the oxygen as the oxidizer gas at an anode side is as follows.



- 15 The generated proton passes through the solid polymer electrolyte membrane. Then, the next reaction is produced at a cathode as follows.



- 20 Accordingly, the electromotive force up to 1.23V is generated between the anode and cathode.

[0004]

- A schematic drawing of a structure of the conventional solid polymer electrolyte fuel cell is shown in Fig. 3. To smoothly and effectively produce the above cell reaction, a gas diffusion electrode 1b in Fig. 3 plays a very important role.

[0005]

- In order to generate the fuel cells, each of the fuel gas and the reaction gas needs to be supplied to surfaces of catalyst. At a cathode side 1ba of the fuel cells, water is generated on a catalytic layer according to the reaction formula 2. The generated water covers the catalytic layer 1d to inhibit the oxidizer gas from being supplied to the catalytic layer 1d.

[0006]

- While at the anode side 1bb, the generated protons according to the reaction formula 1 hydrate and take the water to the cathode 1ba side through the solid polymer electrolyte membrane 1a. Thus, the water in the anode 1bb side is insufficient and the electrolyte membrane 1a becomes dried out. To prevent that, the fuel gas supplied to the anode

1bb side is generally humidified. However, the excessive humidification inhibits the fuel gas from being supplied to the catalytic layer 1d. To avoid the interference due to the water generated by the reactions and the water added by the humidification, a water-repellent 1c such as PTFE (Polytetrafluoroethylene) is generally mixed in the electrode.

[0007]

However, the excessive addition of the water-repellent increases the electric resistance in the bulk and on the surface of the electrodes and decreases the gas permeability. In addition, the excessive hydrophobicity of the electrodes inhibits the humidification of the electrolyte membrane 1a or the water absorbed in the electrolyte membrane 1a is taken away when the fuel gas and the oxidizer gas are provided to thereby cause the electrolyte membrane 1a to be dried out.

[0008]

In order to improve the efficiency of the catalyst by three-dimensionally using the catalyst, a method that a solvent in which the electrolyte membrane 1a has been dissolved is impregnated with a gas diffusion layer together with the catalyst has been well known. In this process, the electrodes acquire proton-conductivity and also hydrophilicity. In addition, as a gas diffusion electrode, the electrode needs to easily and equally distribute the fuel gas and reaction gas to the surface of the catalyst. For this to occur, the porosity content of the gas diffusion electrode needs to be increased so that the gas permeability and diffusion coefficient can be increased.

[0009]

However, the excessive provision of the gas causes the electrolyte membrane 1a to be dried out and thus the proton-conductivity is reduced.

[0010]

In addition, separators 1c of the fuel cells in Fig. 3 are generally formed with concave portions and convex portions in sectional shape, in order to output electric current and supply the fuel gas and the oxidizer gas to the electrode direction. The gas is supplied to the electrode direction through the concave portions of the separators. The gas, however, is not supplied at the convex portions and thus not equally diffused in the vicinity of the surface of the separators 1c. The gas diffusion electrodes, as a role thereof, diffuse the gas that has been supplied from the concave portions in order that the concentration of the gas is equally diffused on the surface of the catalytic layer. For the above function, the electrodes are made of a material having a large gas diffusion coefficient (porous material). However, the electrode having a large gas diffusion (porous) electrode tends to remove water (vapor) from the electrolyte

membrane 1a to dry the electrolyte membrane.

[0011]

As described above, it is necessary for the gas diffusion layer of the fuel cell, as characteristics, to be made with an appropriate balance between hydrophilicity and hydrophobicity, and an appropriate gas permeability.

[0012]

As a conventional technology for achieving the above structure, the conventional electrode is generally formed by the following process. First, carbon black and PTFE formed in a paste with an appropriate dispersion medium are shaped in a sheet form. Then, the sheet is baked to thereby obtain the electrode, or impregnated with carbon paper or carbon cloth that has been prepared separately to be baked to thereby obtain the electrode.

[0013]

[Objects to be solved by the invention]

However, the structure of the above electrode is decided by a complex agglutination/dispersion mechanism which is changed by types, contents and mixing methods of the carbon black, PTFE, dispersion mediums and the like. Therefore, the structure of the electrode cannot be regulated ideally or depending on the designer's intent.

[0014]

The present invention can obviate the above conventional drawbacks and uniformly supply the gas on the surface of the catalytic layer without the electrolyte membrane being dried out by joining, for example, a diffusion layer having a small gas permeability to a catalytic side and another diffusion layer having a large gas permeability to a separator side, as the cathode side for the solid polymer electrolyte fuel cell.

[0015]

The specification of the electrode of the fuel cell needs to be changed depending on the use condition. In addition, two purposes of the solid polymer electrolyte fuel cell, i.e. for a vehicle and house, are considered. Depending on each purpose, each structure of the cell to be used is different. In addition, the thickness of the electrode required for each case is different. According to the present invention, the electrode can easily satisfy the requirement of the thickness of the electrode and the solid polymer electrolyte fuel cell, electrode, and method for producing the same can be easily provided at lower cost.

[0016]

[Means to solve an object]

According to the invention in claim 1 for solving the above technical drawbacks, the solid polymer electrolyte fuel cell including a solid polymer electrolyte membrane having ion exchange properties, an anode disposed on one surface of the polymer electrolyte membrane, and a cathode disposed on the other surface of the polymer electrolyte membrane characterized in that the cathode comprises a joined diffusion layer by joining at least two gas diffusion layers of a first gas diffusion layer and a second gas diffusion layer having different characteristics from each other in a thickness direction of the cathode.

10 [0017]

According to the invention in claim 1, the electrode having the specification that satisfies each requirement is possible according to combination of joining. It is easy to adapt to the thickness requirement of the electrode.

[0018]

15 According to the invention in claim 2 for solving the above technical drawbacks, the solid polymer electrolyte fuel cell and electrode in accordance with claim 1 has a feature of including a hydrophilic water storing intermediate layer disposed between the first gas diffusion layer and the second gas diffusion layer of the cathode.

[0019]

20 According to the invention in claim 2, the water storing intermediate layer 30, which is made of a hydrophilic material such as carbon black, absorbs and holds the water generated by a reaction on the cathode catalyst for preventing the flooding.

[0020]

25 When the dried oxidizer gas reaches the water storing intermediate layer 30, a part of the dried oxidizer gas is diverted to take the water to outside of the cathode. While the remaining oxidizer gas passes through the water storing intermediate layer 30 to be humidified, and is provided to the electrolyte membrane direction. Thus, the excessive humidification can be prevented.

[0021]

30 According to the invention in claim 3 for solving the above technical drawbacks, the solid polymer electrolyte fuel cell and electrode in accordance with claim 1 has a feature that the first gas diffusion layer and the second gas diffusion layer of the cathode differ from each other in at least one of gas permeability in the thickness direction of the cathode, electric resistance and hydrophobicity.

35 [0022]

According to the invention in claim 3, in addition to the effect of claim 2, the water

generated in the catalytic layer can be easily eliminated to the outside of the catalytic layer, owing to the different characteristics of the diffusion layers. Therefore, the flooding is reduced. The dehydration of the electrolyte membrane can be prevented and the electrolyte membrane is prevented from being dried out when the cell is under high temperature or humidification is reduced.

[0023]

According to the invention in claim 4 for solving the above technical drawbacks, the solid polymer electrolyte fuel cell and electrode in accordance with claim 1 has a feature that the first gas diffusion layer disposed at a catalytic layer side of the cathode has a small gas permeability and the second gas diffusion layer disposed at a separator side of the cathode has a larger gas permeability than that of the first gas diffusion layer.

[0024]

According to the invention in claim 4, the electrolyte membrane is not dried out and the gasses can be uniformly provided to the surface of the catalytic layer.

[0025]

According to the invention in claim 5 for solving the above technical drawbacks, a method for producing an electrode of a solid polymer electrolyte fuel cell includes the steps of forming the second gas diffusion layer, forming the first diffusion layer by pressing the second diffusion layer in a thickness direction so that a density becomes larger than the second gas diffusion layer, and thermally pressing to join the first diffusion layer and the second diffusion layer.

[0026]

According to the invention in claim 5, in case of obtaining the electrode of the solid polymer electrolyte fuel cell having the effects of claims 1 to 4, the producing method with easy and lower cost can be achieved.

[0027]

[Embodiment of the invention]

Hereinafter, an embodiment of the present invention is explained referring to attached drawings. As described above, requirements of a cathode of a solid polymer electrolyte fuel cell are resistance to flooding in a catalytic layer and a necessity or a small necessity of humidification of fuel gas from outside.

[0028]

Fig. 2 shows a structure of a cathode of the electrode according to the present invention. The cathode of the present invention has a multiple layer structure of a first gas diffusion layer 10 and a second gas diffusion layer 20. The cathode (gas diffusion layer) 100 includes the first gas diffusion layer 10 disposed at a catalytic layer 30 side,

having small gas permeability and a second gas diffusion layer 20 disposed at a separator side, having a larger gas permeability than that of the first gas diffusion layer 10.

[0029]

5 The first diffusion layer 10 having different gas permeability is made of high-density material layer. The second diffusion layer 20 is made of a porous material layer 20 which has larger porosity than that of the first diffusion layer 10.

[0030]

10 The first diffusion layer 10 is produced by compressing the second gas diffusion layer 20 in the thickness direction thereof so that the first gas diffusion layer 10 will have a higher density than that of the second gas diffusion layer 20.

[0031]

15 Further, a water storing intermediate layer 30 is disposed between the first diffusion layer 10 and the second diffusion layer 20. The water storing intermediate layer 30, which is made of a hydrophilic material such as carbon black, absorbs and holds the water generated by a reaction on the cathode catalyst for preventing the flooding.

[0032]

20 When the dried oxidizer gas reaches the water storing intermediate layer 30, a part of the dried oxidizer gas is diverted to take the water to outside of the cathode. While the remaining oxidizer gas passes through the water storing intermediate layer 30 to be humidified, and is provided to the electrolyte membrane direction. Thus, the excessive humidification can be prevented.

[0033]

25 The first gas diffusion layer 10 and the second gas diffusion layer 20 of the cathode 100 may differ from each other in one or more of gas permeability in the thickness direction of the electrode, electrical resistance and hydrophobicity.

[0034]

30 According to the present invention, since the plural gas diffusion layers are connected to each other or joined at post-process, the structure of the electrode in the thickness direction (thickness, characteristics and so on) can be intentionally and strictly controlled. In addition, by inserting other sheet made of material having different characteristics in water-attraction, water-repellence and so on into surfaces of the gas diffusion layers to be connected to each other, the performance of the intermediate portion of the electrode in the thickness direction can be separately changed.

35 **[0035]**

As the present invention, joining plural electrode sheets which have the same or

different characteristics provides following effects.

[0036]

1. Freedom in designing the electrode is dramatically improved.

[0037]

5 2. According to a combination of the gas diffusion layers to be joined, the specifications of the electrolyte membrane, separators, operating condition and so on can be flexibly changed, so that individual gas diffusion layer for each specification is not required. For example, a change of the thickness of the diffusion layer can be provided by changing the number of gas diffusion layers to be joined.

10 [0038]

3. Since the plural electrode sheets having same or different characteristics and different sizes are partially combined, the cross sectional shape of the electrode or partial characteristics thereof in the direction in the surface can be changed.

[0039]

15 In addition, the electric resistance of the first gas diffusion layer and the second gas diffusion layer may differ from each other. In this case, the electric collecting performance may be improved.

[0040]

A. Production of Electrode

20 (Example)

To produce the electrode shown in Fig. 1, an electrode has been manufactured by the following steps. The gas diffusion layers to be joined have been manufactured based on a method for producing a carbon paper disclosed in Japanese Patent Application No. 2000-136493.

25 [0041]

1. The carbon fiber ($\phi 12.5\mu\text{m}$, length=3mm) and wood pulp are prepared in proportion 6 part to 4 in weight. The carbon fiber and the wood pulp are dispersed in water with an appropriate reagent to form a paste. In this case, the wood pulp is added as binder to bind the carbon fibers so that the gas diffusion electrode can be thin.

30 [0042]

2. The carbon fiber and pulp paste are formed to be a carbon fiber/pulp mixed paper (50g/m^2 , $t=0.2$) by means of the wet papermaking process by hand.

[0043]

35 3. CB (Carbon black), ethylene glycol and isopropyl alcohol are mixed to form a paste. The paste is homogeneously impregnated into the carbon fiber/pulp mixed paper using a screen printer. Then, the ethylene glycol and isopropyl alcohol are removed from the

impregnated carbon fiber/pulp mixed paper at 85°C in the atmosphere until the carbon fiber/pulp mixed paper is dried out.

[0044]

4. The PTFE is impregnated into the carbon fiber/pulp mixed paper by dipping the carbon fiber/pulp paper into PTFE 15 wt % dispersion solution, for example, Polyflon D1 (manufactured by Daikin Industries, Ltd.). After the above dipping, the impregnated carbon fiber/pulp mixed paper is baked at 390°C in the atmosphere for 1 hour, until the PTFE is melted or dissolved. At this time, the wood pulp is burned to be ash, which is left as the vacancies. The resulting vacancies form gas communicating pores.

[0045]

The gas diffusion layers manufactured by the above process are to be the second gas diffusion layer 20.

[0046]

5. For controlling the gas permeability, the second gas diffusion layer 20 is pressed in a press machine to increase their densities. The gas diffusion layer 10 produced by cold-pressing the gas diffusion layer 10 by 200kgf/cm² and is to be the second gas diffusion layer 20.

[0047]

6. As shown in Fig. 1, to form the hydrophilic layer in the intermediate portion of the electrodes, the CB layer is impregnated on one surface of the second gas diffusion layer 20.

[0048]

7. The above impregnated second gas diffusion layer 20 is joined to the diffusion layer 10 by being hot-pressed by 80 kgf/cm² at 160°C for 1.5 minutes. This is a joined diffusion layer 100 of the present invention.

[0049]

<Reference Sample>

1. As in the example of the present invention, carbon fiber (ϕ 12.5 μ m, length=3mm) and wood pulp are prepared in proportion 6 part to 4 in weight. The carbon fiber and pulp are dispersed in water with an appropriate reagent and formed in a paste.

[0050]

2. The carbon fiber and pulp paste are formed to be a carbon/pulp mixed pulp (50g/m², t=0.4)

3. [0051]

CB, ethylene glycol and isopropyl alcohol are mixed to be formed in a paste. The

paste is equally impregnated into both surfaces of the carbon fiber/pulp mixed paper by a screen printer. Then, the ethylene glycol and isopropyl alcohol are removed from the impregnated carbon fiber/pulp mixed paper at 85°C in the atmosphere, until the carbon fiber/pulp mixed paper is dried.

5 [0052]

4. The PTFE is impregnated into the carbon fiber/pulp mixed paper by dipping the carbon fiber/pulp paper into PTFE 15 wt % dispersion solution, for example, Polyflon D1 (manufactured by Daikin Industries, Ltd.). After the above dipping, the impregnated carbon fiber/pulp mixed paper is baked at 390°C in the atmosphere for 1 hour, until the PTFE is melted or dissolved.

10

[0053]

5. The above impregnated carbon/fiber mixed paper is cold-pressed in a press machine to the same thickness as the joined diffusion layer 100, which is a reference diffusion layer.

15

[0054]

<Method for producing electrolyte membrane-electrode assembly>

To measure the fuel cell characteristics of the electrodes manufactured according to the present invention, an electrolyte membrane-electrode assembly was manufactured by following processes.

20

[0055]

1. Platinum supported by carbon, polymer electrolyte solution ("Aciplex solution, a trademark, manufactured by Asahi Chemical Industry Co., Ltd.), water and isopropyl alcohol are mixed in proportion 1:15:2:2 in weight to form a paste.

[0056]

25

2. The above catalyst paste is coated on a surface on the second gas diffusion layer 20 side of the joined diffusion layer 100 and one surface of the reference diffusion layer to a thickness of 300nm. Then the catalyst pastes are dried at 80°C in a vacuum.

[0057]

30

3. The joined diffusion layer 100 and the reference diffusion layer to which the catalyst is applied are cut into 1 and 3 pieces respectively, each having a diameter of $\phi=35.7$ (S=10cm²).

[0058]

35

4. The solid polymer electrolyte membrane (Nafion 112, trademark, manufactured by E.I. du Pont de Nemours and Company) and the above cut electrodes are joined by hot-pressing (160 °C , 40kgf/cm², 1.5min maintained). An electrolyte membrane-electrode assembly is formed accordingly.

[0059]

As combinations of the electrodes, the following two types of electrolyte membrane-electrode assemblies were manufactured.

Anode/cathode = reference diffusion layer/joined diffusion layer

5 Anode/cathode=reference diffusion layer/reference diffusion layer

The effects of the present invention were verified in application to the cathode.

[0060]

B. Characteristic Evaluation

10 Table 1 shows each thickness, gas permeability and bulk electric resistance of the electrodes.

[0061]

As a result, it appeared that the overall characteristics of the joined diffusion layer and the reference electrode layer (thickness, gas permeability, and bulk electric resistance) both scarcely differ after joining.

15 [0062]

[Table 1]

Table 1. Characteristics comparison of each gas diffusion layer

	Diffusion layer 1	Diffusion layer 2	Joined diffusion layer	Reference diffusion layer
Thickness (mm) (under pressure at 20kgf/cm ²)	0.15	0.1	0.26	0.26
N ₂ gas permeability coefficient (μm (Pa·s) ⁻¹)	450	35	32	30
Electric resistance (m Ω · cm ²) (under pressure at 20kgf/cm ²)	18	8	24	23

20 Next, the joined diffusion layer and the reference diffusion layer were disposed at the cathode side for the actual operation of the fuel cells. Then the difference in characteristics was evaluated. In this case, purified hydrogen gas was employed as the

fuel gas, while air was used as the oxidizer gas. Each gas was humidified by passing the gas through thermally controlled water called bubbler. Saturated vapor in each gas corresponding to the water temperature was introduced into the fuel cell. The bubbler temperature at the cathode side was varied to measure the potential-current characteristic (V-I) of the electrode using each diffusion layer, and cell resistance.

[0063]

The operation conditions of the fuel cell are as follows.

Gas Pressure: Purified hydrogen/Air=1atm/2atm

Stoichiometrical Ratio: Purified hydrogen/Air=1.2/4

Cell Temperature: 80°C

Water Temperature: Purified hydrogen/Air=90°C/(a) 50°C, (b)80°C, (c)30°C

[0064]

[Table 2]

Table 2: Cell resistance comparison when each gas diffusion layer was also used

	Joined diffusion layer (mΩ·cm ²)	Reference diffusion layer (mΩ·cm ²)
(a) Bubbler temp.: 50°C	142	141
(b) Bubbler temp.: 80°C	139	137
(c) Bubbler temp.: 30°C	144	233

As shown in Table 2, if either the joined diffusion layer or the reference diffusion layer is employed in the cathode, the difference of the cell characteristics such as a flooding resistance and a dry-up resistance is shown.

[0065]

Fig. 2 shows the V-I characteristics in case that the bubbler temperatures of the air in the example and the reference sample are changed. Fig. 2-(a) shows the V-I characteristics when the bubbler temperature of the air was set at 50°C. Even if either the joined diffusion layer or the reference diffusion layer was used in the cathode, substantially same V-I characteristics were shown.

[0066]

Fig. 2-(b) shows the V-I characteristics in case that the bubbler temperature of the air was set at 80°C in order that the humidification of the air at the cathode side was increased compared to the case of Fig. 2-(a). When the joined diffusion layer was used, the characteristic was almost the same as the case in which the bubbler temperature was set at 50°C. To the contrary, when the reference diffusion layer was used, the potential rapidly dropped in the current density area of 1A/cm² or more. It is considered that the flooding in the catalytic layer was caused due to the increased quantity of the

humidification in the cathode limiting the water elimination performance of the electrode when the reference diffusion layer was used.

[0067]

5 Fig. 2-(c) shows the V-I characteristics in case that the bubbler temperature of the air was set at 30°C in order that the humidification of the air at the cathode side was reduced to a low level. ○ shows the joined diffusion layer while ▼ shows the reference diffusion layer. When the joined diffusion layer was used, the characteristic was almost the same as the case in which the bubbler temperature was set at 50°C. To the contrary, when the reference diffusion layer was used, the potential significantly
10 dropped along with the increment of the current density. It is considered that the solid polymer electrolyte membrane was dried out by reducing the humidification at the cathode side. The above phenomenon is confirmed by the increment of the cell resistance under the fuel cells being operated when the reference diffusion layer is used as shown in Table 2.

15 [0068]

To the contrary, when the joined diffusion layer was used, it is considered that the polymer electrolyte membrane was not dried out by the effect of the water storing intermediate layer and thus the potential did not drastically drop. The above phenomenon is confirmed by the fact that the cell resistance was scarcely changed when
20 the joined diffusion layer was used as shown in Table 2.

[0069]

As described above, the electrode structured by joining the plural layers provides the following effects. The gas diffusion layer permits the water generated in the catalytic layer to be smoothly eliminated to the outside. In addition, the gas diffusion layer
25 humidifies the electrolyte membrane. By joining a diffusion layer having hydrophobicity to the catalytic layer side and the other diffusion layer having hydrophilicity to the separator side, the following effects are obtained.

1. The water generated in the catalytic layer can be easily eliminated to the outside of the catalytic layer, owing to the different characteristics of the diffusion layers.
30 Therefore, the flooding is reduced.

[0070]

2. The dehydration of the electrolyte membrane can be prevented and the electrolyte membrane is prevented from being dried out when the cell is under high temperature or humidification is reduced.

35 [0071]

By joining the diffusion layer having the low gas diffusing performance to the catalytic

layer side and the other diffusion layer having the high gas diffusing performance to the separator side, the electrolyte membrane is not dried out and the gasses can be uniformly provided to the surface of the catalytic layer.

[0072]

- 5 Further, by inserting or coating material having different characteristic on the marginal surface of the diffusion layer to be joined, the electrode can have a different function. For example, if a metal mesh is disposed between the diffusion layers, then the electric correcting performance of the electrode may be improved.

[0073]

- 10 The specification of electrode of the fuel cell needs to be changed depending on the use condition. Lately, the solid polymer electrode fuel cell is mainly intended to be used for a vehicle and a house. For the vehicle, since the fuel cell is highly pressurized and operated in large electric current area, the flooding can easily occur. To prevent the flooding, the electrode tends to have high hydrophobicity. For the house, since the
15 fuel cell is at normal pressure, the electrolyte membrane tends to be dried. To prevent the electrolyte membrane from being dried, the electrode for home use has a slightly lower hydrophobicity compared to the electrode for the vehicle. In addition, since each of the anode and cathode has different functions, the various electrodes corresponding to the functions are demanded.

20 [0074]

- In case that the electrode is structured by combining as in the present invention, the diffusion layers having different specifications are prepared to be combined so that the electrode can be formed to meet each requirement. Depending on each purpose, each structure of the cell to be used is different. In addition, the thickness of the electrode
25 required for each case is different. The electrode structured by combining can easily satisfy the requirement of the thickness.

[0075]

[Effect of the invention]

- According to the present invention as described above, the solid polymer electrode fuel
30 cell and electrode including a solid polymer electrolyte membrane having ion exchange properties, an anode disposed on one surface of the polymer electrolyte membrane, and a cathode disposed on the other surface of the polymer electrolyte membrane characterized in that the cathode comprises a joined diffusion layer by joining at least two gas diffusion layers of a first gas diffusion layer and a second gas diffusion layer
35 having different characteristics from each other in a thickness direction of the cathode. Therefore, the electrode having the specification that satisfies each requirement is

possible according to combination of joining. In addition, it is easy to adapt to the thickness requirement of the electrode.

[Brief description of drawings]

5 [FIG. 1] a cross-sectional view of a cathode according to an embodiment of the present invention

[FIG. 2] a graph showing a evaluation result of a joined diffusion layer and a reference diffusion layer of a fuel cell according to the embodiment of the present invention

[FIG. 3] a cross-sectional view of a solid polymer electrolyte fuel cell

[Description of reference numerals]

- | | | |
|----|-----|--|
| 10 | 1a | solid polymer electrolyte membrane |
| | 1b | gas diffusion electrode (1ba: cathode, 1bb: anode) |
| | 1c | separator |
| | 1d | catalytic layer |
| | 1bb | anode |
| 15 | 1ba | cathode |
| | 10 | first gas diffusion layer |
| | 20 | second gas diffusion layer |
| | 100 | joined diffusion layer (cathode) |

[DOCUMENT]

Abstract

[Abstract]

5 **[Object]**

It is possible to achieve an electrode having a specification that satisfies each requirement by differentiating the combination of joining. To provide a solid polymer electrolyte fuel cell that can easily adapt to the thickness requirement of the electrode.

[Means to solve]

- 10 The solid polymer electrolyte fuel cell including a solid polymer electrolyte membrane 1a having ion exchange properties, an anode 1bb disposed on one surface of the polymer electrolyte membrane, and a cathode 1ba disposed on the other surface of the polymer electrolyte membrane characterized in that the cathode 1ba includes a joined diffusion layer by joining at least two gas diffusion layers of a first gas diffusion layer
- 15 10 and a second gas diffusion layer 20 having different characteristics from each other in a thickness direction of the cathode.

[Selected drawing]

FIG. 1

20

[FIG. 1]

CB mixed water –repellent

Carbon fiber

Absorption of water generated

5 Humidified air

Non-humidified air

Discharge of water

Joined diffusion layer 100

[FIG. 3]

10 1c: separators

1a: solid polymer electrolyte membrane

1c: water-repellent

1d: catalytic layer

Conductive fiber

15 Enlarged view of electrode portion

1b: gas diffusion electrode